REMARKS

Background Remarks

In paragraph 4 of the Office Action, the examiner appropriately states the meaning of "directly electroplated" to be that no surface treatment or pretreatment step(s) exist. A "directly electroplateable resin (DER) is taught in the instant specification as a conductive polymer, including a growth rate accelerator, which can be directly immersed, without pretreatment, in an electroplating bath to accomplish electrochemical deposition of a coating which is typically metallic.

The examiner has stated an opinion that whether the metal coating is patterned (selective) or not is only part of a design scheme and is conventional. Applicant respectfully disagrees. Complete electrodeposit coverage of a substrate is normally far less complex than selective metal coverage. Selective metal deposition has its own unique and often difficult requirements compared to complete deposit coverage. A first consideration is the definition of the boundary line between the plated and unplated surfaces. One normally wishes this to be as smooth and defined as possible. However, this can be difficult, as verified in the Hans U.S. Patent 4,224,118 at column 1, lines 35-45. A first concern is the tendency for electrodeposits to preferentially deposit at an edge between conductive and nonconductive regions. This is a result of the bath having a higher current carrying capacity in the region of an edge as compared to a broad surface. This situation can result in a ragged or raised edge of electrodeposited metal at the boundary, a condition commonly referred to in the industry as edge "berry buildup". In some cases the extra stresses associated with the increased metal electrodeposit at edges actually cause the metal to pull away from the substrate. Thus, adhesion values can be of added concern in a selectively electroplated article. Alternately, if the substrate is in the form of a thin film, substrate curling at edges can be a problem. A further concern is that the electrodeposit in a selectively electroplated article is normally a projection above the surface. In an effort to keep the surface as smooth as possible, electrodeposit thickness should be reasonably uniform and at a minimized thickness consistent with other requirements. If there is significant nonuniformity in electrodeposit thickness, aesthetic and performance issues arise. Using simple conductive resin substrates having low current carrying capacity, significant variations in electrodeposit thickness can occur over extended lengths. Therefore, the addition of a "coverage rate accelerator" in the directly electroplateable resins of the instant invention is critical.

Three of the references cited by the examiner do not teach the use of directly electroplateable resins. The first two are U.S. Patents 3,772,161 to Bogard et al. and 4,224,118 to Hans. These references teach use of the conventional preplating and "electroless" (chemical) deposition techniques to render the plastic surface conductive for subsequent electrodeposition. Both Bogard et al. and Hans teach application of a mask coating (otherwise known to the art as a "stop-off" coating) to an ABS article prior to conventional "electroless" treatment. The mask comprises specialty materials resistant to the etching solution so that the masking material does not accept the catalyst which

initiates "electroless" metal plating. "Electroless" plating therefore occurs only on the unmasked surface regions of exposed ABS plastic. Specialty materials are required for mask coatings and are therefore expensive. Such masking is extremely laborious and costly. In the example of U.S. 3,772,161 a flat plaque was used. However, in practice a 3-dimensional object would normally require a spray mask, since this may be the only practical way to apply a preplating resistant, robust and sufficiently thick mask coating to a complicated 3-d object. Spray coat application using a mask is very labor intensive batch process and expensive. In addition, the mask material must be sprayed using organic solvents. The significant overspray and solvent containment adds complexity. The mask material must be dried/baked (stated as 10 minutes at 140 degrees F in the example of U.S. 4,224,1180. Finally, the mask material is still susceptible to attack and deterioration by the vigorous etching. In the case of a permanent, robust mask such as taught in U.S. 4,224,118, the mask material still is deleteriously altered. This reference suggests such alteration could be painted or buffed (column 2, lines 33 – 37), either of which would add expense, complexity and labor. In the case of a removable mask such as taught in U.S. 3,772,161, such removal requires additional processing including solvent washing and waste containment. Either situation involves considerable additional expense, complication and waste.

The conventional technology taught in the Bogard et al. and Hans references not only involves difficult and expensive preparation of the insulating substrate but also a difficult and expensive metallization process for producing the conductive surface on which electrodeposition is to be performed. In order to elaborate, the major steps of this conventional plating approach taught will be described below.

The steps of the conventional "electroless" plating process are:

a. Cleaning the substrate of contaminants.

b. Etching the surface to create a microscopically roughened surface which is easily "wetable". Etching solutions are normally very thick, vigorous solutions such as mixtures of chromic and sulfuric acids. They present significant environmental and rinsing problems. Etching is very sensitive to surface morphology and polymer type. Thus proper etching can only be achieved with a few selected polymers. The most commonly used is ABS.

c. Neutralizing the surface.

d. Exposing the etched/neutralized surface to one or more solutions to deposit tiny particles of a catalyst (often palladium) which will initiate "electroless" deposition through chemical reduction of metal from solution. The catalyst will be adsorbed onto the surface of an "etched" surface, such as ABS, but not be adsorbed onto a surface resistant to the etch, such as the "mask coating" used in the cited references.

e. Exposing the catalyzed article to an 'electroless" bath to deposit metal onto the catalyzed surface, such as the exposed etched ABS, but not onto the etch resistant "masking" material.

The conventional "electroless" process also includes many rinsing steps between the primary steps --a-- through --e-- above. It is thus complicated and uses expensive chemicals which are environmentally difficult. Pollution control and containment adds to cost. Further, rates of "electroless" metal deposition are relatively slow, so that most often actual metal electroplating must follow the initial "electroless" metal deposition in order to achieve required metal thickness in reasonable time.

Thus, the cited U.S. Patents 3,772,161 and 4,224,118 to Bogard et al. and Hans respectively teach a very restricted substrate (ABS) using a very restricted fabrication (injection molding) using a very laborious and environmentally difficult process (mask spraying) in combination with a very expensive, complicated and environmentally difficult preplating process (conventional electroless metal deposition). These problem issues are precisely what the instant invention solves.

A third reference cited by the examiner is U.S. 4,038,042 to Adelman. As noted by the examiner, this patent teaches conductive polymeric compositions which can be electroplated following a <u>preplating</u> process employing a vigorous chromic/sulfuric etch plus neutralizing rinse. The Adelman compositions thus are not "directly electroplateable resins" according to the examiner's correct definition. The Adelman teaching requires the use of etching and rinsing pretretments to the surface prior to electrodeposition. For instance, in Adelman's Example 1, Column 20, lines 14 through 23, eight preplating steps are listed taking in excess of 23 minutes to achieve. Thus, Adelman did not teach a "directly electroplateable resin". Furthermore, the vigorous etches and rinses taught by Adelman could affect the nonplated surfaces of a selectively electroplated article in a dramatically deleterious way, both mechanically and visually. The Adelman compositions did not have a "coverage rate accelerator" as taught in the instant invention. Thus, reported electrodeposit coverage rates were slow, at best in the range of 1 inch/minute. This is too slow to be of practical value, since it would result in exceedingly long coverage times and substantial nonuniformity in electrodeposit thickness, especially if attempts were made to cover long thin traces of low current carrying capacity. But long traces or thin material cross sections are often characteristic of selectively electroplated articles, dictated for functional performance, processing demands or minimization of cost. Finally, electrodeposit thicknesses of .001 to .0015 inch were taught by Adelman. These thicknesses would normally be unsuitable to achieve the fine line definition often required for selectively electroplated articles. It is clear that Adelman did not teach a "directly electroplateable resin" and that the teachings would not be suitable to produce selectively electroplated articles. Adelman is notably silent about the possibility of his compositions and techniques as suitable for selective electrodeposition.

The fourth reference cited by the examiner is U.S. 4,425,262 to Kawai et al. This reference refers to a "directly electroplateable resin", one wherein "no surface treatments or pretreatments exist". Kawai et al. teach a non-discriminating direct electroplating technique. There is no evidence that this technology ever achieved any commercial success. The reference makes no mention of suitability of the directly electroplateable resin for the specialized requirements of selective electroplating. As noted by the examiner, Kawai et al. is silent regarding whether "the metal coatings are selectively plated (or patterned)". Indeed, the reference is not only silent, it teaches away from such selectivity. The reference examples describe flat plaques, about .08 inch thick. The plaques are plated with electrodeposits some .002 inch thick. While such large thicknesses may be appropriate (and indeed advantageous) for an article <u>entirely covered</u> with electrodeposit, such thicknesses could be inappropriate for a selectively electroplated article because of the edge effects and surface irregularities discussed above. Thus, neither the patent teaching nor commercial experience would persuade a person of normal skill in the art to choose the Kawai et al. teachings for selective electroplated structures.

Finally selective electroplating not only requires coverage of long, thin traces with fine line definition and good adhesion, but also suitability of coatings and thermoplastic compounds for fabrication and low cost. As taught in the instant specification, it is only through his independent and private development that the author is aware of the unique suitability of directly electroplateable resin technology for production of a myriad of selectively electroplated structures.

<u>Claim Rejections</u>

<u>35 U.S.C. 102(b)</u>: The examiner rejected pending claim 1 as anticipated by Hans, U.S. 4,224,118. However, pending claim 1 requires the presence of a directly electroplateable resin. For the reasons stated above, Hans did not approach a teaching involving a directly electroplateable resin.

<u>35 U.S.C. 102/103</u>: The examiner rejected pending claims 1 – 6 as anticipated or obvious over Kawai et al., U.S. 4,425,262. The examiner correctly observes that Kawai et al. is silent about the metal coating being selectively plated. However, the examiner suggests that selectivity is but part of the conventional design choice. For the reasons described above, applicant respectfully disagrees with examiner's position that selective/nonselective choices are interchangeable. Indeed, as pointed out above, Kawai et al. actually teach away from successful selective electroplating in that their reported electrodeposit thicknesses are excessive for most selective applications. The examiner further states that the Kawai resin compositions had electrical resistance < 300 ohms over a 1 cm. distance. However, this measurement was for the material <u>receiving the electrodeposit</u>. In original claims 2 – 6, a limitation is made of greater than .001 ohm-cm. for a <u>non-DER</u> surface portion which receives substantially no electrodeposit as discussed in the embodiments. Thus, the resistance measurements of Kawai et al. are not related to the resistivities stated in the claim limitations.

35 U.S.C. 102/103: The examiner rejected claims 1 – 6 as anticipated or obvious over Adelman, U.S. 4,038,042. The examiner states that "Adelman teaches a plastic composition which can be directly electroplated with a metal. Applicant respectfully disagrees, since Adelman's teaching requires the preplating steps including aggressive etching, neutralization and rinsing as pointed out above. Adelman is notably silent about selective deposition and indeed, as pointed out above, his reportedly slow electrodeposit coverage rates would thwart effective selective deposition.

35 U.S.C. 103: The examiner rejected claims 2 – 6 as being unpatentable over Kawai et al. (U.S. 4,442,262) or Adelman (U.S. 4,038,042) in view of Hans (U.S. 4,224,118) or Bogard et al. (U.S. 3,772,161). Applicant argues that such combinations are improper. Adelman does not teach a "directly electroplateable resin" and requires multiple preplating steps. Neither Bogard et al. nor Hans teach or contemplate the use of a directly electroplateable resin. Both require the use of expensive and complicated preplating. In both cases a chemically (electroless) deposited metal is initially applied in contact with the plastic in order to allow subsequent electrodeposition.
A more detailed analysis of the possible combinations follows.

(1) If one were to consider applying the complete teachings of the Bogard et al. or Hans but use a directly electroplateable resin in place of the ABS plastic taught, a number of detrimental results would occur.

- The specific masking materials taught in Bogard et al. and Hans, being specifically tailored to ABS resin, would likely not properly adhere to and protect the DER surface.
- The directly electroplateable resin surface would react considerably differently to the etching and catalyst steps involved in electroless deposition. Indeed, it is likely that no electroless reaction would occur, or if it did, electrolessly deposited metal adhesion would be poor.
- There is no incentive or persuasive reason to replace the ABS resin of Bogard et al. and Hans with a directly electroplateable resin. DER's are compounded materials, significantly more expensive than raw ABS resin.

(2). One might suggest that the masking material compositions taught by the Bogard et al. and Hans teachings be used with a DER substrate to give selectively exposed DER surface regions which would be selectively electroplated. This suggestion is neither obvious nor practical. The compositions taught by Bogard et al. and Hans for masking materials comprise expensive specialty polymers dissolved in mixtures of organic solvents. The specific compositions were specifically tailored to adhere to ABS resin substrates and to at least partially resist the deleterious effects of the vigorous chemistry intrinsic in ABS preplating. There is no suggestion that these compositions would form satisfactory masks on a DER surface comprising significantly differing polymers and conductive fillers.

(3) It is not proper to simply state that masking a DER surface would result in successful selective electroplating. Relatively harsh processing is normally involved in preparing conventional materials, including metals, prior to electrodeposition. In practice any successful mask must be relatively thin, yet resist critical defects from forming during

processing. Thus masking is very material and process specific. For example, in the case of an ABS substrate, the ABS is insulating and a pinhole in a mask may not plate through. In contrast, when plating a DER, metal deposition would occur through pinholes since masking does not eliminate conductivity under the mask.

Thus, stating that simply masking a DER surface is sufficient for successful selective electroplating ignores the specificities and requirements of widely differing processing. Indeed, such a statement also fails to recognize a substantial inventive step achieved by the instant inventor. The applicant has recognized that the chemical and mechanical severity involved in the electroplating of directly electroplateable resins is substantially reduced compared to typical electroplating processes for conventional materials. Using directly electroplateable resins, no preplating, involving harsh etchants and processing, is involved and relatively benign electroplating solutions are available. Thus, defect formation resulting from conventional harsh processing can be substantially eliminated. This recognition has enabled the applicant to identify and demonstrate expanded masking possibilities for use specifically with directly electroplateable resin formulations. Indeed, applicant can state from his own personal observations and development work that novel and inexpensive masking techniques, such as thin printed and spray applied coatings, using conventional inks including possibly water based or UV curable formulations, may be acceptable. This is a direct result of using the mild processing schemes suitable when electroplating is used exclusively, independent of the harsh processing required with conventional plastics or even metal preplating. Further, since these additional masking techniques become an option for use with directly electroplateable resins, greater latitude in part design is available. For example, the fact that pad printing of masks can be considered means that the three dimensional capabilities of pad printing can be exploited when applying a mask for directly electroplateable resins. Colors and mechanical characteristics of the mask coatings remain unaltered through DER electroplating, as clearly suggested by the results of Example 1 of the instant specification.

Comments On The New And Amended Claims

Upon entry of the amendment, claims 1 – 25 are pending in the application, with claims 1, 2, 3, 5, 6 and 7 being independent claims. Since the appropriate fee for the extra 3 independent claims was submitted with the original application, I understand no additional "independent claim" fee is required. However, the claim additions herein bring the total claims to 25. Therefore, the "extra total claims" fee of $ 125. (Check # 238) and fee transmittal are included.

According to the Examiner's instructions in Paragraph 1 of the Office Action, the acronym "DER" has been spelled out in its full name in all claims.

Applicant states that all claim limitations have proper antecedent basis and support in the specification and claims as originally filed. Because the changes introduce no new matter, their entry is respectfully requested.

Should questions arise concerning the application, the applicant suggests contact according to the contact information stated below.

Respectfully submitted,

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